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Regional business cycles in New Zealand: Do they exist? What might drive them?

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Abstract

We use National Bank of New Zealand Regional Economic Activity data, to identify and characterise classical business cycle turning points, for New Zealand's 14 regions and aggregate New Zealand activity. Using Concordance statistic measures, logistic model and GMM estimation methods, meaningful regional business cycles have been identified and a number of significant associations established. All regions exhibit cyclical asymmetry for both durations and amplitudes, and synchronisations between aggregate NZ activity and each region are contemporaneous. The regional cycles rarely die of old age but are terminated by particular events. The regions most highly synchronised with the NZ activity cycle are Auckland, Canterbury, and Nelson-Marlborough; those least so are Gisborne and Southland. Noticeably strong co-movements are evident for certain regions. Geographical proximity matters, and unusually dry conditions can be associated with cyclical downturns in certain regions. There is no discernable evidence of association with net immigration movements, and no significant evidence of regional cycle movements being associated with real national house price cycles. The agriculture-based nature of the New Zealand economy is highlighted by the strong influence of external economic shocks on rural economic performance. In particular, there is considerable evidence of certain regional cycles being associated with movements in New Zealand's aggregate terms of trade, real prices of milksolids, real dairy land prices and total rural land prices.

JEL classification
C22, E32, R11, R12, R15

Keywords
Classical business cycle; Turning Points; Regional business cycles; Concordance statistics; New Zealand

1 Introduction

The aims and methodology of this paper are motivated by three key factors. First, to establish how useful the National Bank of New Zealand's (NBNZ) *Regional Trends* data are for business cycle analysis. Second, to do this in the context of recent arguments that Classical business cycle dating methods should be preferred to Growth Cycle techniques as the basis for establishing cycle turning points and key cycle characteristics.[1] Thirdly, to investigate a range of factors which might have driven or lagged the regional cycles.

Business cycle analysis in New Zealand over the past decade has examined aggregate real GDP series,[2] and more recently, sectoral series.[3] We are not aware of a study that has focussed on the possible importance of regional cycles.[4] When the NBNZ releases results from its regional trends survey each quarter, commentary and data analysis features ranking of the regions from highest to lowest growth rates over short run horizons such as the latest quarter and the past year; also what factors might have been associated with those outcomes. However, examination of the longer run series shows that every region can lay claim to either the highest or lowest growth rate at least once during the full sample period. This paper therefore complements the NBNZ's shorter run analysis by focusing on regional business cycle properties over a medium term horizon, and on the extent to which the cycles may differ and be driven by particular factors over this time frame.

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[1] See, for example, Harding and Pagan (2002). The key arguments favouring this are that the Classical approach avoids controversies associated with de-trending methods, and is more transparent in its approach, through focusing directly on characteristics of the underlying time series rather than on deviations from trend.

[2] See Kim, Buckle and Hall (1994, 1995), who utilise both Classical and Growth cycle methods to establish business cycle turning points and key business cycle characteristics, for production and expenditure-based GDP series; Hall, Kim and Buckle (1998) who examine the cross-correlations of New Zealand's production-based real GDP growth cycles with those of its Pacific Rim trading partners; and Buckle et al. (2002b) who construct a structural VAR model of the New Zealand business cycle from growth cycle series.

[3] See Buckle et al. (2002a).

[4] See Kouparitsas (2002) for a study of US regional cycle co-movements.

The broad aims are therefore: (1) to identify and characterise Classical business cycles for New Zealand's 14 regions and for aggregate New Zealand activity; (2) to establish the degree of synchronisation (or co-movement) of activity between the regions and aggregate NZ activity, and amongst regions; and (3) to conduct preliminary analysis of aggregate level factors which could be associated with the various regional cycles.[5]

Specific questions addressed include the following:[6]

1. Are aggregate NBNZ "activity" cycles real GDP "business" cycles?
2. Are there meaningful regional cycles, what are their key duration, amplitude, and synchronisation characteristics?
3. Which regional cycles have some association with others?
4. Do the cycles co-move contemporaneously, or do key regions act as drivers to others?[7]
5. Are all or any of the following factors associated in some meaningful way with regional activity cycles? Geographical proximity, unusual climatic conditions,[8] net immigration changes, key commodity prices, and housing and land prices?

The remainder of this paper is structured as follows: Section 2 sets out the methodology used for dating our classical turning points, characterising their durations and amplitudes, and establishing the statistical significance of their synchronisations. Computational and interpretational challenges, associated with our preferred Concordance statistic, are made transparent. Specific empirical results are summarised in Section 3, separately for aggregate and regional activity levels. Our broader conclusions are summarised in Section 4.

[5] The emphasis in this paper is on establishing robust bivariate associations; multivariate relations will be investigated in subsequent research.

[6] Diebold and Rudebusch (1999, 2001) have recently evaluated empirical research evidence on durations of expansions and contractions, and co-movements of cyclical variables.

[7] In this context, for example, it has been suggested that for each of the last two (growth) recessions, South Island and/or rural regions have led NZ out of its business cycle trough, with increased activity then spilling over into greater metropolitan activity.

[8] See, for example, Buckle et al. (2002b, p 31) who report that a "number of days of soil moisture deficit" variable is an important contributor to the New Zealand business cycle.

2 Methodology

2.1 Classical turning points and cycle characteristics

Dating Expansions and Contractions in Economic Time Series

The popular folklore is that two consecutive quarterly declines (increases) in real GDP define an economic contraction (expansion). However, researchers typically use more formal definitions of "contractions" and "expansions". The most common definition, and the one we use in this paper, is that embedded in the algorithm developed by Bry and Boschan (1971). The definition essentially implies that any series has shifted from expansion to a contraction, if the value of the series has declined from its previous (local) peak. This approach is in line with the traditional literature on business cycles initiated by Burns and Mitchell (1946).

The definition of contractions and expansions embedded in the Bry-Boschan algorithm is objective and can be easily automated. This means that different researchers around the world can replicate the work of other researchers. This algorithm has been used to automate the dating of business cycles, by King and Plosser (1994), Watson (1994), and Harding and Pagan (2002, 2003). The algorithm has also been applied, in suitably modified form, to the dating of bull and bear markets in equity prices by Pagan and Sossounov (2003) and to the dating of booms and slumps in commodity markets by Cashin, McDermott and Scott (2002).

The Bry-Boschan algorithm is a pattern-recognition procedure that determines turning points in the data. The algorithm proceeds in three steps[9]:

1. A potential set of peaks and troughs is determined by turning point rules that define a local peak in series x as occurring at time t whenever $\{x_t > x_{t\pm k}\}$, $k=1,\ldots,K$, while a local trough occurs at time t whenever $\{x_t < x_{t\pm k}\}$, $k=1,\ldots,K$
2. Peaks and troughs are checked to make sure they alternate.

[9] For further details on applying this algorithm in a New Zealand context, see Kim, Buckle and Hall (1995, section 3).

3. The peaks and troughs are revised according to a range of criteria, the most important of which are elimination of completed cycles whose duration is less than 15 months and phases with duration of less than 5 months.

Implementation of the Bry-Boschan algorithm delivers some technical advantages. First, the dating of turning points in the series is largely independent of the sample used.[10] Second, the peaks and troughs identified using the algorithm are derived from a definition of the cycle which allows us to deal with the data in *levels*, hence avoiding the somewhat subjective choice of which detrending method to use. Expansions and contractions are then described as periods of absolute decline (rise) in any given series, not as a period of below-trend (above-trend) growth in the series.[11]

Measures of Duration and Amplitude, and associated hypothesis tests

Once the peaks and troughs in each of the aggregate and regional activity time series have been established, key features of expansions and contractions in the national and regional economies can be measured. First, we analyse the average durations (in quarters) for each phase. Secondly, the average amplitudes of the aggregate and regional phase movements (in percent change) are examined. Then, two non-parametric tests are conducted.[12] The Brain and Shapiro (1983) statistic tests for duration dependence, the null hypothesis being that the probability of exit from a phase is independent of the length of time the series has been in that phase. The Spearman rank correlation statistic allows testing whether there is a significant relationship between the absolute amplitude (severity) and duration of expansions (and contractions). The null hypothesis is that there is no rank correlation between the phase severities and durations.

[10] To the extent that the end points of the series need to be treated differently from the rest of the series, the addition of new observations may see the final peak or trough date revised, but all preceding turning points in the series will remain unchanged.
[11] See Watson (1994).
[12] See also Diebold and Rudebusch (1990) and Cashin and McDermott (2002) for conduct of these tests.

2.2 Measuring the Synchronization of Cycles

To obtain the degree of co-movement or synchronisation of our business cycle series, we focus primarily on the simple non-parametric Concordance statistic (Harding and Pagan, 2002, 2003). The statistic describes the proportion of time two series, x_i and x_j, are in the same phase "contraction" or "expansion". Concordance is also a useful concept of co-movement, because it represents a way to summarize information on the clustering of turning points—that is, whether expansions (contractions) turn into contractions (expansions) at the same time.

We are particularly interested in how the cyclical patterns of regional activity compare to each other. To facilitate this, for each of the two time series (x_i and x_j) for which we have cyclically dated turning points, we award a value of one when both series are expanding or contracting, and award a value of zero otherwise. Following Harding and Pagan (2002), let $S_{i,t}$ be a binary random variable taking the value unity when the classical cycle for series x_i is in an expansion phase and zero when it is in a contraction phase. Define the binary random variable $S_{j,t}$ in the same way for the classical cycle for series x_j. The index of concordance in the cycles of the two series is then

$$C_{ij} = T^{-1}\left\{\sum_{t=1}^{T}\left(S_{i,t}\cdot S_{j,t}\right)+\sum_{t=1}^{T}\left(1-S_{i,t}\right)\left(1-S_{j,t}\right)\right\}, \quad (1)$$

where S_i and S_j are as defined above, T is the sample size and C_{ij} measures the proportion of time the two series are in the same phase. To interpret C_{ij}, a value of say 0.66 for the index indicates that x_i and x_j are in the same phase (that is, expanding or contracting together) 66 percent of the time.[13]

[13] The series x_i is exactly pro-cyclical (counter-cyclical) with x_j if $C_{ij} = 1$ ($C_{ij} = 0$). As it is a proportion, the values of the index of concordance, C_{ij}, are clearly bounded between zero and one. Faced with a realised concordance index of, for example, 0.7, it is natural to assume that this is large relative to zero. However, even for two unrelated series the expected value of the concordance index may be 0.5 or higher. For example, consider the case of two fair coins being tossed. The probability that both coins are in the same phase—that is, both are heads or both tails—is 0.5.

In measuring concordance we are interested in whether two series move together in any given period. That is, we are explicitly and solely interested in *periodicity*—the proportion of time two series spend together in expansions or contractions—and not in the amplitude of movements in a given phase (expansion or contraction).

More generally, a disadvantage of C_{ij} is that it does not provide a means of determining if the extent of co-movement (or synchronization) between cycles in the two series is statistically significant. To do so we need a concordance test statistic. However, if the expected value of C_{ij} is evaluated under the assumption of mean independence, then, following Harding and Pagan (2002), the *t*-statistics examining the null hypothesis of no concordance between the two series can be computed from the regression coefficient estimate attached to $S_{i,t}$ in the regression of $S_{j,t}$ against a constant term and $S_{i,t}$. In addition, given that the errors from such a regression are unlikely to be *i.i.d.*, due to the strong likelihood of serial correlation or heteroscedasticity in $S_{i,t}$, the *t*-ratio for the regression coefficient has been made robust to higher-order serial correlation and heteroscedasticity. Positive serial correlation in $S_{i,t}$ biases hypothesis tests toward rejecting the null of no concordance.

One problem we are left with is that the estimated slope coefficient from the regression of $S_{j,t}$ against a constant term and $S_{i,t}$ will be different from the inverse of the estimated coefficient of from the regression of $S_{i,t}$ against a constant term and $S_{j,t}$. This problem can be acute if the sample size is small. While the underlying number of quarterly observations seems sufficient, the number of completed cycles is limited. To address this problem we use a GMM estimator. GMM does not care which of $S_{i,t}$ or $S_{j,t}$ is the endogenous variable since we effectively have the moment condition

$$\mathrm{E}((S_{i,t} - \overline{S}_{i,t})(S_{j,t} - \overline{S}_{j,t}) - a) = 0, \qquad (2)$$

where $\overline{S}_{i,t}$ is the mean of the time series $S_{i,t}$, when we want to test if $a = 0$. [14]

[14] We thank Adrian Pagan for suggesting this solution.

Another advantage of GMM estimators is that they can be made robust to heteroscedasticity and serial correlation by incorporating heteroskedastic and autocorrelation consistent (HAC) covariance matrix estimators.[15]

3 Empirical Results

Previous studies dating New Zealand business cycles have utilised real GDP data. Hence, prior to presenting results for our 14 regional cycles, we demonstrate the extent to which aggregate NZ activity cycles are real GDP business cycles. The NBNZ data span the March 1975 to March 2002 quarters, but the real GDP series is available only from June 1977.

3.1 Aggregate Activity

The aggregate NBNZ activity series, and Statistics New Zealand's (SNZ) production based real GDP series, move very similarly, except between mid-1989 and late-1993 (Figure 1). NBNZ activity started growing again from the September 1991 quarter, whereas sustained real GDP increases are recorded only from December 1992[16].

The two series have three contractionary phases in common, but the relatively short and shallow contractionary phase for NBNZ aggregate activity in the late 1990 and early 1991, contrasts markedly with 3 contractionary phases over a longer period for real GDP (Table 1).

[15] GMM estimation requires a weighting matrix to be picked for efficient estimation. We follow the usual practice of using the asymptotic covariance matrix. To estimate this matrix a kernel must be chosen (to ensure that the estimate is positive semi-definite) and a bandwidth parameter selected (to control the amount of serial dependence allowed in the estimate). In this paper we use the Bartlett kernel which takes the form $k(u) = (1-|u|)1(|u| \leq 1)$, where $1(\cdot)$ is the unit indicator function. The bandwidth (b) is based on the number of observations in the sample, via the Newey-West formula $b = [4(T/100)^{2/9}]$, where $[\cdot]$ denotes the integer part of the argument. In our case, this implies a bandwidth of 4, which is convenient since we are using quarterly data that has the potential for fourth order serial correlation. Further details of implementing the GMM estimator can be found in Ogaki (1993). It should also be noted, in the context of this research, that too small a number of cycles can be associated with potentially misleading t-statistics.

[16] Previous experience with dating business cycles from real GDP data suggests the somewhat different results during this time period are no greater than the variations which can be observed from successive SNZ revisions of both real GDP data series and observations.

In both cases, the average durations and amplitudes are noticeably greater for expansions than for contractions, suggesting cyclical asymmetry in common but of somewhat different strengths (Table 1).

Measures of synchronisation show the two series co-move contemporaneously (Table 2). The most significant Concordance statistic has the two series in phase an impressive 84 per cent of the time.

3.2 Regional Activity

The regional cycles, their durations and amplitudes

It is clear that meaningfully different regional cycles exist (Tables 3, 4). Visual inspection shows that all regions except Wellington experienced contractions associated with the Asian financial crisis and summer drought period of 1997-98. Gisborne was the region worst affected by contractionary activity associated with "reforms" of the late 1980s and early 1990s. Perhaps surprisingly, the subdued 1991-92 activity that is clear from real GDP, but not NBNZ aggregate activity data, is not consistently widespread over the regional cycles.

All regions exhibit cyclical asymmetry, for both their durations and amplitudes. Expansions have lasted for around 26 quarters on average, but contractions for just over 4 quarters; while for amplitudes, peaks are on average 28 per cent higher than troughs, and troughs around 3 percent lower than peaks.

Another specific pointer to meaningfully different regional cycles comes from the long duration expansions and short duration contractions, such as for Canterbury and Nelson-Marlborough, which contrast with the three or more lengthy contractions recorded for Gisborne, Taranaki and Southland. Similarly, the expansions of Canterbury and Nelson-Marlborough, and the contractions for Gisborne and Taranaki, provide the greatest cycle amplitudes.

Two non-parametric tests were conducted, to provide additional information on the nature of the regional expansions and contractions (Table 5). The Brain-Shapiro (1983) statistic tested whether there was any tendency for the phases to have a fixed duration. Our empirical results, albeit for small numbers of expansions and contractions, showed that for all regions except the West Coast, duration dependence could not be accepted. This means that the regional cycles rarely die of old age but are terminated by particular events. The Spearman rank correlation statistic provides correlations between durations and amplitudes of business cycle phases, and hence a measure of their *shape*. Here, our empirical results show that the shapes of business cycle *expansions* have been similar for most regions, Waikato, Hawkes Bay and Southland being the exceptions. Contractions, however, have come in somewhat different shapes and sizes for 5 regions and thus for aggregate New Zealand.

Co-movements/synchronisations

Bi-variate cross correlation, Concordance statistic and GMM test measures show synchronisations between aggregate NZ activity and each region are contemporaneous (Table 6). The regions most highly synchronised with the NZ activity cycle are Auckland, Canterbury, and Nelson-Marlborough; the least so are Gisborne and Southland. Applying a one percent significance level for the test of no concordance yields 11 regional business cycles as being significantly contemporaneously concordant to the national business cycle. The three regions not concordant are Northland, Bay of Plenty and Gisborne, although Bay of Plenty would be if we had used a 5 percent significance level. Ten of the 11 regional business cycles, which are contemporaneously concordant with the national business cycle, are also concordant at one lag when we use a one percent significance level but all of them are when we use a 5 percent significance level. No regional business cycle is significantly concordant at any lags greater than one.

Noticeably strong co-movements between regions have been obtained for Canterbury and Nelson-Marlborough (which are contiguous), Hawkes Bay, Nelson-Marlborough and Canterbury (which may have climate, horticulture and viticulture in common), and Waikato, Taranaki and Southland (which have dairying in common) (Table 7). The regions with major urban centres of Auckland, Wellington and Christchurch also show strong evidence of concordant business cycles.

Factors associated with regional activity cycles?

Given we have established the existence of meaningful regional business cycles, the next issue is whether it is possible to identify any key economic factors which are significantly associated with those cycles. The factors considered as either drivers or as lagged responses, were distance between regions, unusually dry weather conditions, net immigration changes[17], prices that signal the transmission of external shocks (such as the terms of trade[18] and real dairy product prices as drivers of the cycles), and domestic prices that subsequently reflect the impact of major shocks (such as real house prices and real rural land prices).

First we report the results of an econometric investigation on the impact of distance between regions and the synchronisation of their business cycles. This is a binary outcome problem, for which the logistic probability model was used. The goal is to predict the probability that a pair of regions have a significantly synchronised business cycle based on the distance between the pair. The model is

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_0 + \beta_1 D_{ij} + \varepsilon_{ij} \tag{3}$$

where p_{ij} is the probability that the regions i and j are significantly concordant, D_{ij} is the travelling distance between the main centres of the regions i and j. If the regions are separated by the Cook Strait a travelling distance equal to three hours driving time was added (approximately the time it takes the ferry to cross the strait from Wellington to Picton). The distance between main centres is used as a proxy for transportation costs, which we presume, are a barrier to regional economic spillovers.

[17] No net migration variable was found to have significant association with regional business cycle phases, at one-tail five and one percent critical values. These empirical results are therefore not reported.

[18] Consistent with Buckle et al. (2002b) and Wells and Evans (1985), and reflecting the differing commodity compositions of New Zealand's exports and imports, we also investigated the possibility of separate effects on regional activity from export and import prices. No real merchandise import price variable nor real petroleum products import price variable was found to have a robustly negative association with regional business cycle phases, for one-tail five percent and one percent critical values. These empirical results are also not reported.

The logistic model is estimated using a maximum likelihood nonlinear estimation routine and a sample of 105 region pairs. The individual p_{ij}s are not observed; instead, we have information on whether each pair is significantly concordant or not. Thus, the *measured* dependent variable is $y_{ij} = 1$ if the regional pair is significantly concordant and $y_{ij} = 0$ otherwise. We order the observations so that those associated with significant concordance are the first n_1 observations and the remaining n_2 ($n_1+n_2=N$) observations are those associated with non-significant concordant pairs. The likelihood function to be maximised is then

$$L = \prod_{k=1}^{N} \left[1 + \exp(-\beta_0 - \beta_1 D_k)\right]^{-y_k} \left[-\exp(-\beta_0 - \beta_1 D_k\right]^{-(1-y_k)} \tag{4}$$

where k is an index over the ordered pairs. Standard optimisation routines can be used to maximise this function to obtain estimates of β_0 and β_1. The maximum likelihood estimation procedure has a number of desirable statistical properties. All the parameter estimates are consistent, asymptotically efficient, and asymptotically normal, so the analogue of the t-test can be applied.

The estimation results for the logarithmic equation (with asymptotic standard errors in parentheses) are

$$\begin{aligned} &\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \underset{(0.426)}{0.460} - \underset{(0.0011)}{0.0044} D_{ij} \\ &LR = 28.2 \qquad \text{Pseudo } R^2 = 0.26 \end{aligned} \tag{5}$$

where the LR-test is a test of the significance of the entire logistic model and follows a Chi-square distribution with one degree of freedom. The results indicate that distance between regions does affect whether a region's cycles are synchronised with those of another. Logit equation estimates suggest that, for each kilometre the main centre of a region is apart from another, the probability of a linked business cycle is reduced by .004.[19]

[19] To check the robustness of the logit regressions we also used a linear equation where we regressed concordance between two regions on the travelling distance between the two regions. The regression results are C_{ij} = 0.897 (80.5) - 0.000086 (5.9) D_{ij}. The linear model indicates a strong influence of distance on the proportion of time two regions are in the same phase (the t-statistics reported in parenthesis are highly significant). The coefficient estimates imply, for example, that the distance between Auckland and Southland lowers the percentage of time the regions are in the same phase by over 15 percent.

It also means that there are no synchronised regions that are more than 500 kilometres apart. Distance accounts for over a quarter of the variation in the probabilities that the regions are concordant.

Do unusually dry conditions coincide with business cycle downturns?

Our next question is also one of geography, but this time we want to determine whether it is weather patterns that have any discernible effects on regional economy activity. Examining the impacts of weather developments on economic activity has a long pedigree. One of the earliest studies in this area was the controversial work by Jevons (1884) who investigated the link between sunspot cycles and economic activity, with a presumed influence of sunspots on atmospheric conditions and thus on agricultural production. Recently, Brunner (2002) has studied the impact of El Niño on world commodity prices. He found that the El Niño Southern Oscillation cycle can account for almost 20 percent of commodity price inflation over the past several years and that a one standard deviation positive surprise in this cycle can raise real commodity price inflation about 3.5 to 5 percentage points. Impacts of these magnitudes would clearly be large enough to influence economic activity in countries like New Zealand, whose exports are dominated by commodities.

Unusually dry weather conditions, can impact directly on agricultural production and thus national production figures. Buckle *et al.* (2002b) found that the drought conditions at the time were the dominating influence on New Zealand's 1998 recessionary activity; more important than the Asian financial crisis, which has been the more commonly offered explanation.

To identify periods of unusually dry weather, we use soil moisture deficit data provided by NIWA's Climate Data Centre. For each of the key recording sites in our 14 regions we take the number of days per quarter that NIWA record the soil to be in moisture deficit. If this figure for a given quarter is more than one standard deviation above the average, we declare this quarter as unusually dry and label it with a one; otherwise we label it with a zero. This procedure yields a time series of zeros and ones that we can use to test to see if it is concordant with regional economic activity. In this instance we are looking for a negative relationship between unusually dry conditions and economic activity.

To test whether the concordance between regional climate conditions and regional economic activity is statistically significant, we use the GMM procedure described earlier.

- The empirical results presented in Table 8 show that while many coefficients have the expected negative sign, only the contemporaneous coefficients for Waikato and Gisborne, and the one quarter lagged association for Gisborne, are statistically significant[20]. There are not many periods of unusual dryness in our sample, but when they did occur (e.g. 1997-98), Waikato and Gisborne's dairy and other agricultural production, and hence their regional activity, was hit noticeably hard[21]. There is very weak evidence of the impact of unusual dryness for other rural dominated regions (e.g. contemporaneous t-statistics greater than one for Bay of Plenty, Taranaki, and Manawatu-Wanganui), and reassuringly, no discernable association for regions with major urban centres (such as Auckland, Wellington, and Canterbury). Otago is a region with very mixed geography; its dry areas don't have many stock, and those that have sufficient rainfall to have stock, rarely have drought and are close to a major urban centre (Dunedin). Similarly, Southland seldom lacks sufficient rain.

Do macroeconomic shocks coincide with regional business cycles?

We now turn from geography and climatology to macroeconomics, and examine whether there are any identifiable links between regional activity and macroeconomic shocks. As indicated above, the essentially aggregate factors that we considered were: (1) prices reflecting material external shocks and which would act as potential drivers of the cycles, such as the terms of trade and real dairy product prices; and (2) domestic prices that subsequently reflect the impact of these external and other shocks, such as real house prices and real rural land prices.

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[20] These conclusions are robust to defining an unusually dry quarter as coming from a period of at least two consecutive unusually dry quarters rather than just one such quarter.

- External price shocks, as *potential drivers* of regional cycles (Table 9) There are strong contemporaneous associations between official terms of trade movements and regional cycle phases, for Waikato, Taranaki, and Canterbury/Nelson-Marlborough. One quarter ahead terms of trade movements are also significant for the Waikato. Real milksolids price results confirm these strong associations, and extend influences of a leading nature to a 12 month time horizon. Contemporaneous milksolids prices are also significant for Southland, emphasising further the major influence of the dairy industry. Perhaps reassuringly, no clear linkages have been established for primarily urban regions.

The influence of commodity prices and climate conditions on economic activity in rural regions is noteworthy, especially given the dramatic changes in agricultural policy over the sample period. A variety of farm subsidisation schemes were introduced and intensified in the early part of our sample and subsequently were removed following the economic reforms that started in 1984. These reforms had a large impact on the agricultural sector, encouraging diversification into deer farming, horticulture and wine production (Evans *et al*., 1996, p 1891). Despite the wide-ranging structural changes to agriculture over the sample period the simple bilateral relationships between rural activity and key commodity prices and climate conditions go a long way in explaining rural business cycles.

- Internal price shocks, *reflecting* regional cycle movements (Table 10)

Perhaps the most surprising result here is that there are no statistically significant associations between regional cycle phases and real national house price movements. Nor are there significant associations between Auckland's regional activity cycles and that region's real house price movements. This would suggest that while real house price movements are undoubtedly influential in various ways for a number of regions, there would seem to be more influential factors than real (value-added) regional activity that have driven the real prices of (new and existing) houses.

[21] For example, Gisborne is a strong sheep and beef region, and when rural incomes are strong or weak, farmers tend to spend or stop spending money in the region, largely because of the distance

There are, however, significant associations between regional cycle movements and (contemporaneous and one-quarter-lagged) movements in both real dairy land and total rural land prices. This emphasises further, crucial roles for both dairying and wider rural activity, in helping to explain regional cycle activity. The consistently strongest associations for dairying land prices are for Taranaki, Otago and Southland; and when total rural land prices are considered, Waikato provides similarly powerful evidence.

4 Conclusion

Utilising the National Bank of New Zealand's Regional Economic Activity data, we have identified Classical business cycle turning points for New Zealand's 14 regions and for aggregate New Zealand activity. The duration and amplitude characteristics for their expansion and contraction phases have been established, and some statistical tests conducted. The degree of synchronisation of activity between the regions and aggregate NZ activity, and amongst regions, has been investigated. We also report results from preliminary analysis of various factors that could potentially have been drivers of the regional cycles.

Aggregate NBNZ "activity" cycles are not dissimilar to those obtained from Statistics NZ real GDP data. The two have three contractionary phases in common, and their Concordance statistic measure of synchronisation is strong. The two series also have average durations and amplitudes that are noticeably greater for expansions than contractions, i.e. display cyclical asymmetry. The key difference, though, relates to the period from mid-1986 to mid-1991, when the relatively short and shallow contractionary phase for NBNZ activity contrasts with the 3 contractionary phases from the SNZ series. These marked differences call into question traditionally held views on the extent of recessionary activity in NZ from the mid-1980s to the early 1990s.

Meaningful regional business cycles have been identified. Visual inspection shows that all regions except Wellington experienced contractions in activity associated with the successive summer droughts and the Asian financial

of Gisborne from other urban centres.

crisis of 1997-98. Gisborne was the region worst affected by contractionary activity associated with "reforms" of the late 1980s and early 1990s. Perhaps surprisingly, the subdued 1991-92 activity that is clear from real GDP data, is not consistently widespread in the regional cycles. Another pointer to meaningfully different regional cycles comes from the long duration expansions and short duration contractions for Canterbury and Nelson-Marlborough, which contrast with the three or more lengthy contractions recorded for Gisborne, Taranaki and Southland. Similarly, the expansions of Canterbury and Nelson-Marlborough, and the contractions for Gisborne and Taranaki, provide the greatest cycle amplitudes.

All regions exhibit cyclical asymmetry for both durations and amplitudes. Statistical tests, albeit for small numbers of expansions and contractions, showed that: (i) for all regions except the West Coast, duration dependence could not be accepted, i.e. cycle phases have been terminated by particular events rather than dying of old age; (ii) the *shapes* (in the sense of correlations between durations and amplitudes) of business cycle *expansions* have been similar, though contractions tend to have come in somewhat different shapes and sizes.

Concordance statistic measures show synchronisations between aggregate NZ activity and each region are contemporaneous. The regions most highly synchronised with the NZ activity cycle are Auckland, Canterbury, and Nelson-Marlborough; the least so are Gisborne and Southland. Noticeably strong co-movements between regions have been obtained for Canterbury and Nelson-Marlborough (which are contiguous), Hawkes Bay, Nelson-Marlborough and Canterbury (which may have climate, horticulture and viticulture in common), and Waikato and Taranaki (which have dairying in common).

So, what factors have we established as consistent with our essentially contemporaneous business cycle co-movements? In a positive sense, we have established that distance between regions matters, but on the negative front, net migration and real (petroleum products) import prices were found not to be drivers of regional business cycle phases.

Unusually dry weather conditions have been associated on relatively infrequent occasions, with business cycle phases in the Waikato and Gisborne regions.

External price shocks, through aggregate official terms of trade movements and real milk solids prices, have been strongly associated with business cycle phases in the Waikato, Taranaki, and Canterbury/Nelson Marlborough. Milksolids price associations are also evident for Southland.

Internally, and perhaps most surprisingly, regional cycle movements are not reflected in real house price cycles, even for the Auckland region; but for Taranaki, Southland, Otago, and Waikato, regional cycle movements have been reflected quite rapidly in dairy land and total rural land prices.

More broadly on potential drivers and reflectors of regional business cycle movements, our results suggest that an hypothesis based on rural regions driving New Zealand out of recessionary activity, and metropolitan areas being the followers, cannot be supported. Rather, it would seem aggregate terms of trade and dairy milksolids prices drive activity in key rural areas, and that these cyclical phases have been quite quickly reflected in rural land prices in those areas. In short, over this quite lengthy (1975 to 2002) sample period, rural business cycle activity has remained a remarkably dominant factor in key regions.

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Data Appendix

The real GDP series is from Statistics New Zealand and is on a production basis. Quarterly data from 1977(2) to 2002(1) are used.

The regional economic activity data are from the National Bank of New Zealand Ltd. Quarterly data from 1975(1) to 2002(1) are used. Twenty-three series are used to calculate the composite indices of regional economic activity including: business confidence; consumer confidence; retail sales; new motor vehicle registrations; regional exports; registered unemployment; building permits approved; real estate turnover; household labour force data; job ads; and accommodation survey data. All quarterly rates of change are calculated on seasonally and inflation adjusted data.

The 14 regions included in our sample are Northland, Auckland, Waikato, Bay of Plenty, Gisborne, Hawke's Bay, Taranaki, Manawatu-Wanganui, Wellington, Nelson-Marlborough, West Coast, Canterbury, Canterbury, Otago, Southland. A national measure of activity is formed by constructing a (fixed) weighted average of the regions. The weights are based on relative gross region products. A number of New Zealand's regions are small by international standards, and are the outcome of defining surrounding regions (e.g. Manawatu-Wanganui). They may therefore be potentially susceptible to "single factor domination".

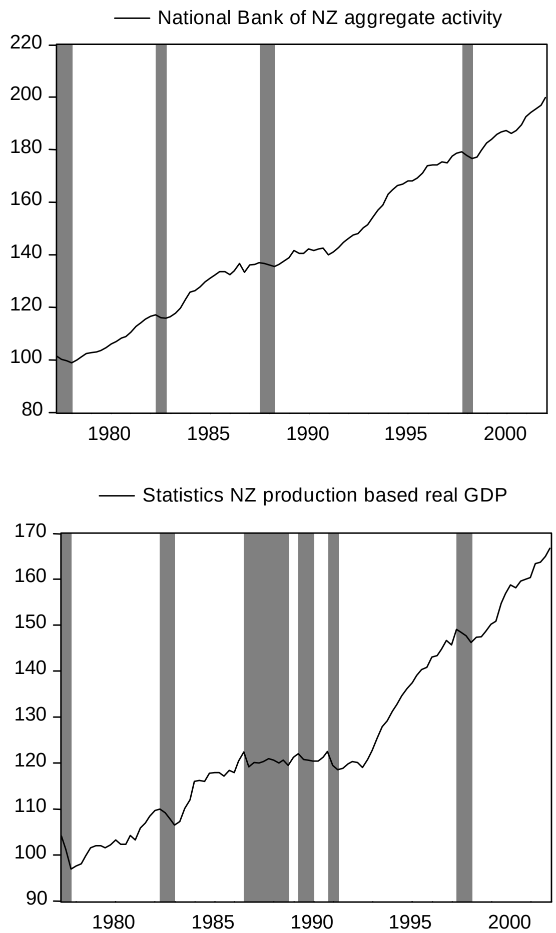
The Net Permanent and Long-Term Migration, and Permanent and Long-Term Arrivals (Immigrants) series were sourced from Statistics New Zealand (SNZ). Also sourced from SNZ were nominal series for the official terms of trade, merchandise import prices, and petroleum products prices. Real series are the nominal series deflated by the All Groups CPI.

The indicator of unusually dry conditions in each region was derived from NIWA data on "days of soil moisture deficit".

Nominal prices received for milksolids were sourced from *Dairy Statistics 2000-2001*, Livestock Improvement Corporation Limited. To turn this into a real price series, the nominal prices have been deflated by the All Groups CPI.

The house prices indexes are from Quotable Value New Zealand and show the average movement in sales prices as they are related to their Government valuation. The rural and dairy land price indexes are compiled by Quotable Value New Zealand and are constructed in a similar manner to the house price indexes. All the real house and land price series are the nominal series deflated by the All Groups CPI.

Figure 1: Expansions and contractions in aggregate New Zealand cycle activity 1977(2) to 2002(1).



Note: Contractions are denoted by the shaded regions, expansions by the unshaded regions.

Table 1. Durations and Amplitudes of Completed Expansions, Contractions and Cycles

New Zealand Aggregate Real Economic Activity and Real GDP, 1977(2) to 2002(1)

NBNZ Aggregate Activity					**SNZ Real GDP (Production Based)**				
Peak	**Trough**	**Expansion T to P**	**Contraction P to T**	**Cycle P to P**	**Peak**	**Trough**	**Expansion T to P**	**Contraction P to T**	**Cycle P to P**
1977(1)	1978(1)	-	4	-	-	1977(4)	-	-	-
1982(2)	1982(4)	17	2	21	1982(2)	1983(1)	18	3	-
1987(3)	1988(2)	19	3	21	1986(3)	1988(4)	14	9	17
					1989(2)	1990(1)	2	3	11
					1990(4)	1991(2)	3	2	6
1997(4)	1998(2)	38	2	41	1997(2)	1998(1)	24	3	26
Average Duration†		24.7	2.75	27.7			12.2	4.0	15.0
Amplitude									
Average (% change)		23.0	-1.66				11.6	-2.40	
Average (% change per quarter)		0.97	-0.59				0.91	-0.80	

† Durations are expressed in quarters

Table 2. Synchronisation: Aggregate Real Economic Activity and Real GDP 1977(2) to 2002(1)

Lead/lag k	Correlation Corr(SNZ(t),NBNZ(t+k))	Concordance C(SNZ(t),NBNZ(t+k))	GMM test† t(SNZ(t),NBNZ(t+k))
-8	-0.03	0.71	-0.85
-4	-0.10	0.70	-1.37
-1	0.35	0.81	1.82**
0	0.49	0.84	5.79***
1	0.51	0.85	2.23**
4	0.10	0.75	0.14
8	-0.14	0.67	-0.95

† The GMM test is the t-test on the coefficient C in the implicit equation dSNZ(t)*dNBNZ(t+k)-C=0, where the series have been de-meaned. The GMM estimation was conducted using the Bartlett kernel with a fixed bandwidth of 4. The null hypothesis of no concordance is rejected for one-tail tests, if the test result is greater than critical values of 2.36 (1 percent level, denoted ***), 1.66 (5 percent level, denoted **), and 1.29 (10 percent level, denoted *)

Table 3. Classical Turning Points for Cycles in Regional Economic Activity

NBER (Bry and Boschan) Method, 1975(1) to 2002(1)

	NZ	ND	AK	WK	BP	GS	HB	TA	MW	WG	NM	WC	CA	OT	SD
P	1977(1)		1977(1)	1977(1)			1977(1)	1977(1)	1977(1)	1976(4)	1977(1)	1976(1)	1977(1)	1977(1)	1977(1)
T	1978(1)		1978(1)	1978(1)			1978(1)	1978(1)	1978(1)	1978(1)	1978(1)	1978(1)	1978(1)	1978(1)	1978(1)
P												1980(1)			
T												1980(4)			
P	1982(2)		1982(1)		1982(2)				1982(1)	1982(2)		1982(3)		1982(2)	1982(1)
T	1982(4)		1983(1)		1983(1)				1982(4)	1982(4)		1983(2)		1982(4)	1983(2)
P		1986(2)		1985(3)	1985(4)	1985(1)	1986(3)	1984(3)	1985(3)			1986(2)		1985(1)	1984(4)
T				1986(4)	1986(4)				1986(4)			1986(4)		1986(1)	1986(2)
P	1987(3)		1987(3)	1987(3)	1987(3)				1987(4)	1987(2)		1987(3)		1986(3)	1987(4)
T	1988(2)	1988(1)	1988(2)	1988(2)	1988(2)	1988(1)	1988(1)	1988(2)	1988(3)	1988(2)		1988(2)		1988(3)	1988(2)
P					1989(2)	1988(4)			1989(2)					1989(2)	1989(2)
T					1989(4)				1989(4)					1989(4)	
P			1990(1)	1990(3)				1990(3)	1990(3)	1990(1)					
T			1991(1)	1991(1)		1991(1)		1991(2)	1991(1)	1991(1)					1991(1)
P							1996(1)		1995(4)			1996(2)		1996(2)	1996(1)
T							1996(3)					1996(4)			
P	1997(4)	1997(4)	1997(4)	1997(3)	1997(4)	1997(4)	1997(4)	1997(2)			1997(3)	1997(4)	1997(3)		
T	1998(2)	1998(2)	1998(2)	1998(3)	1998(3)	1998(2)	1998(3)	1998(2)	1998(2)		1998(2)	1998(2)	1998(2)	1998(2)	1998(2)
P										2001(2)					
T															

P = Peak, T = Trough
NZ = aggregate New Zealand activity, ND = Northland, AK = Auckland, WK = Waikato, BP = Bay of Plenty, GS = Gisborne, HB = Hawkes Bay, TA = Taranaki, MW = Manawatu/Wanganui, WG = Wellington, NM = Nelson/Marlborough, WC = West Coast, CA = Canterbury, OT = Otago, SD = Southland

Table 4. Durations and Amplitudes of Completed Expansions and Contractions in Regional Economic Activity, 1975(1) to 2002(1)

Region	Duration†				Average Amplitude (% change)			
	Expansion		Contraction		Expansion	Contraction	Expansion	Contraction
	No.	Average	No.	Average			Per Quarter	
Northland	1	39.0	2	4.50	39.5	-4.32	1.01	-0.91
Auckland	4	17.0	5	3.40	21.2	-1.95	1.16	-0.61
Waikato	4	17.0	5	3.60	19.8	-1.96	1.10	-0.57
Bay of Plenty	4	12.5	5	3.00	15.9	-2.97	1.27	-1.08
Gisborne	2	15.0	3	7.67	10.2	-7.33	0.90	-0.99
Hawkes Bay	3	23.7	4	3.75	20.7	-2.73	0.77	-0.68
Taranaki	3	19.7	4	6.50	25.2	-4.30	1.21	-0.78
Manawatu/Wang.	6	9.3	7	4.14	10.7	-3.34	1.10	-0.96
Wellington	4	20.8	4	3.75	19.5	-2.65	0.88	-0.70
Nelson/Marlb.	1	78.0	2	3.50	87.3	-1.75	1.12	-0.54
West Coast	6	11.0	7	3.29	9.3	-2.32	0.80	-0.81
Canterbury	1	78.0	2	3.50	89.6	-3.55	1.15	-0.92
Otago	5	11.4	6	4.67	11.5	-3.58	1.18	-0.94
Southland	5	10.4	6	5.50	9.3	-2.89	0.92	-0.55
Average	3.5	25.9	4.4	4.34	27.8	-3.26	1.04	-0.79
New Zealand	3	24.7	4	2.75	11.6	-2.40	0.91	-0.80

† Durations are expressed in quarters

Table 5. Formal Tests on the Nature of Expansions and Contractions in Regional Economic Activity, 1975(1) to 2002(1)

	Expansions		**Contractions**	
	Brain-Shapiro	**Spearman**	**Brain-Shapiro**	**Spearman**
Northland	--	--	--	--
Auckland	-0.35	1.00*	-1.56	-0.11
Waikato	-0.25	0.80	-1.24	0.87*
Bay of Plenty	0.94	1.00*	-1.60	-0.22
Gisborne	--	--	-0.40	1.00*
Hawke's Bay	-0.07	0.87	0.10	1.00*
Taranaki	-0.63	1.00*	1.14	1.00*
Manawatu-Wanganui	0.65	0.84*	1.53	0.95*
Wellington	0.24	1.00*	-0.83	0.63
Nelson-Marlborough	--	--	--	--
West Coast	1.39	0.94*	2.20*	0.06
Canterbury	--	--	--	--
Otago	0.11	1.00*	0.17	0.79*
Southland	0.21	0.67	-0.73	0.60
New Zealand	0.58	1.00*	0.66	0.63

Notes: The Brain-Shapiro statistic is used to examine duration dependence in regional business cycles. The null hypothesis of the Brain-Shapiro statistic is that the probability of terminating a phase (expansion or contraction) is independent of the length of time a series has been in that phase. An asterisk denotes that the null hypothesis is rejected (using a five percent critical value for a two-tailed test); any result greater than the critical value of 1.96 (in absolute value) indicates duration dependence in the series.
The Spearman rank correlation coefficient examines whether there is any relationship between duration and amplitude of a phase. The null hypothesis is no rank correlation between the amplitude of a phase and its duration. An asterisk denotes that the null hypothesis is rejected (using a one-tailed test) at the five percent level of significance, where the five percent critical value for significant correlations is given by $1.65/N^{1/2}$, N being the number of expansions or contractions in the sample period.

Table 6. Synchronisation: Aggregate Real Economic Activity and Regional Activity, 1975 (1) to 2002 (1)

Lead/lag $k^{\dagger\dagger}$	Correlation $Corr(R_i(t),NBNZ(t+k))$	Concordance $C(R_i(t),NBNZ(t+k))$	GMM test[†] $t(R_i(t),NBNZ(t+k))$
Northland			
-1	0.34	0.89	1.44*
0	0.34	0.89	1.25
1	0.12	0.85	0.42
Auckland			
-1	0.53	0.89	7.45***
0	0.78	0.94	>10.00***
1	0.53	0.89	6.46***
Waikato			
-1	0.42	0.86	2.32**
0	0.59	0.90	4.03***
1	0.42	0.86	3.02***
Bay of Plenty			
-1	0.22	0.83	0.94
0	0.49	0.89	2.08**
1	0.40	0.87	1.48*
Gisborne			
-1	0.12	0.76	0.63
0	0.13	0.76	0.36
1	-0.03	0.72	-0.60
Hawke's Bay			
-1	0.48	0.89	2.38***
0	0.57	0.91	3.74***
1	0.40	0.87	2.17**
Taranaki			
-1	0.38	0.81	2.57***
0	0.46	0.83	3.19***
1	0.24	0.77	1.64*
Manawatu-Wanganui			
-1	0.35	0.78	3.16***
0	0.49	0.82	7.30***
1	0.35	0.78	4.92***

Table 6. (continued)			
Lead/lag k[††]	**Correlation** Corr(R_i(t),NBNZ(t+k))	**Concordance** C(R_i(t),NBNZ(t+k))	**GMM test**[†] t(R_i(t),NBNZ(t+k))
Wellington			
-1	0.51	0.89	2.86***
0	0.59	0.90	4.07***
1	0.34	0.84	2.22**
Nelson-Marlborough			
-1	0.53	0.93	5.51***
0	0.66	0.94	6.23***
1	0.41	0.91	2.19**
West Coast			
-1	0.35	0.81	2.89***
0	0.57	0.87	7.65***
1	0.42	0.83	5.98***
Canterbury			
-1	0.53	0.93	5.51***
0	0.66	0.94	6.23***
1	0.41	0.91	2.19**
Otago			
-1	0.43	0.81	8.47***
0	0.57	0.84	>10.00***
1	0.36	0.79	4.99***
Southland			
-1	0.31	0.74	3.55***
0	0.44	0.78	6.90***
1	0.31	0.74	5.23***

[†] The GMM test is the t-test on the coefficient C in the implicit equation $dR_i(t)*dNBNZ(t+k)-C=0$,
where the series have been de-meaned, and R_i is the binary activity series for region i. The GMM estimation was conducted using the Bartlett kernel with a fixed bandwidth of 4. The null hypothesis of no concordance is rejected for one-tail tests, if the test result is greater than critical values of 2.36 (1 percent level, denoted ***), 1.66 (5 percent level, denoted **), and 1.29 (10 percent level, denoted *)

[††] Leads and lags of 4 and 8 quarters were also tested. None provided higher Concordance values that were statistically significant.

Table 7. Concordance Matrix

	ND	AK	WK	BP	GS	HB	TA	MW	WG	NM	CA	WC	OT	SD
Northland	--	0.83	0.86	0.89	0.87	0.93	0.84	0.74	0.81	0.89	0.89	0.82	0.81	0.67
Auckland	0.74	--	0.88	0.85	0.78	0.85	0.81	0.82	0.92	0.89	0.89	0.83	0.79	0.83
Waikato	3.84	2.88	--	0.88	0.83	0.88	0.91	0.86	0.83	0.90	0.90	0.83	0.82	0.79
Bay of Plenty	4.02	1.69	3.05	--	0.83	0.83	0.79	0.82	0.79	0.83	0.83	0.82	0.81	0.76
Gisborne	2.56	1.02	2.71	3.39	--	0.80	0.84	0.74	0.75	0.76	0.76	0.69	0.79	0.76
Hawke's Bay	8.05	1.95	3.20	1.44	1.35	--	0.84	0.78	0.83	0.91	0.91	0.83	0.84	0.72
Taranaki	8.02	1.94	14.52	2.13	3.38	4.21	--	0.81	0.78	0.83	0.83	0.75	0.85	0.79
Manawatu-Wanganui	1.03	4.11	8.98	5.88	1.94	1.97	3.07	--	0.75	0.80	0.80	0.76	0.88	0.89
Wellington	0.55	5.88	2.09	0.60	0.79	1.67	1.73	1.42	--	0.84	0.84	0.79	0.76	0.75
Nelson-Marlborough	0.48	5.43	0.93	0.36	0.08	5.65	1.76	1.51	1.02	--	1.00	0.83	0.81	0.76
Canterbury	0.48	5.43	0.93	0.36	0.08	5.65	1.76	1.51	1.02	--	--	0.83	0.81	0.76
West Coast	0.48	2.51	2.79	2.46	0.21	3.35	1.57	2.57	1.68	4.84	4.84	--	0.77	0.72
Otago	6.03	1.94	3.87	4.05	2.40	6.79	0.01	5.98	1.29	1.58	1.58	2.39	--	0.84
Southland	0.03	11.37	4.41	3.44	1.95	0.89	2.69	9.44	2.03	1.73	1.73	1.48	4.44	--

Notes: The figures above the diagonal are the concordance measures between regions, defined by equation (1). The figures below the diagonal are t-statistics of the null hypothesis of no concordance derived from the GMM estimation of equation (2)

The t-statistic is the t-test on the coefficient C in the implicit equation dREGION_1*dREGION_2 - C = 0 where the series have been de-meaned. The GMM estimation was conducted using the Bartlett kernel with a fixed bandwidth of 4. The one percent critical value is 2.36

Table 8. Impact of unusually dry conditions on regional business activity

	Contemporaneous		Reg. activity lag 1 qtr		Reg. activity lag 4 qtrs	
	Concordance	t-stat	Concordance	t-stat	Concordance	t-stat
Northland	0.17	-0.92	0.14	-1.52*	0.18	-0.60
Auckland	0.24	-0.41	0.30	0.21	0.27	0.14
Waikato	0.17	-2.71***	0.23	-1.06	0.30	0.39
Bay of Plenty	0.20	-1.03	0.24	-0.37	0.25	-0.22
Gisborne	0.22	-2.16**	0.20	-2.50***	0.23	-1.58
Hawke's Bay	0.21	-0.40	0.21	-0.33	0.26	0.12
Taranaki	0.26	-1.02	0.28	-0.41	0.30	0.17
Manawatu-Wanganui	0.28	-1.11	0.32	-0.14	0.31	-0.45
Wellington	0.26	-0.05	0.28	-0.03	0.26	-0.11
Nelson-Marlborough	0.14	-0.89	0.16	0.02	0.15	-0.17
Canterbury	0.16	-0.06	0.18	0.11	0.19	0.34
West Coast	0.23	-0.03	0.25	0.84	0.24	0.15
Otago	0.35	0.22	0.35	0.26	0.33	0.09
Southland	0.35	0.16	0.37	0.54	0.38	0.62

Notes: Null hypothesis is that regional soil moisture deficit cycles are not concordant with regional business cycles. The test of concordance is defined in the text and Table 7.
The t-statistic is computed from de-meaned data, and a negative sign denotes an inverse relationship between the two variables. A Concordance value of less than 0.5 also reflects an inverse relationship.

Table 9. Concordance tests of terms of trade, milksolid prices & regional economic activity

	Contemporaneous		Reg. activity lag 1qtr		Reg. Activity lag 4 qtrs	
	Concordance	t-stat	Concordance	t-stat	Concordance	t-stat
Official terms of trade						
Northland	0.51	0.34	0.51	0.38	0.50	-0.07
Auckland	0.57	0.97	0.55	0.73	0.36	-2.11
Waikato	0.63	7.36***	0.63	6.96***	0.41	-0.92
Bay of Plenty	0.53	0.59	0.53	0.36	0.42	-0.95
Gisborne	0.57	1.06	0.53	0.40	0.48	-0.20
Hawke's Bay	0.53	0.44	0.51	0.30	0.46	-0.38
Taranaki	0.61	1.72**	0.57	1.01	0.45	-0.50
Manawatu-Wanganui	0.57	1.01	0.53	0.38	0.36	-2.13
Wellington	0.54	0.69	0.50	0.13	0.35	-2.70
Nelson-Marlborough	0.55	>10.00***	0.53	1.16	0.42	-1.36
Canterbury	0.55	>10.00***	0.53	1.16	0.42	-1.36
West Coast	0.50	0.05	0.51	0.21	0.36	-1.68
Otago	0.56	0.92	0.48	-0.18	0.35	-1.94
Southland	0.57	0.97	0.49	-0.06	0.29	-4.08
Real milksolid prices						
Northland	0.50	0.41	0.51	0.98	0.51	>10.00***
Auckland	0.50	0.27	0.49	0.22	0.46	-0.10
Waikato	0.54	2.37**	0.57	1.63*	0.58	4.77***
Bay of Plenty	0.44	-0.26	0.45	-0.11	0.48	0.17
Gisborne	0.55	0.86	0.55	0.75	0.50	0.13
Hawke's Bay	0.51	0.87	0.53	0.65	0.53	0.46
Taranaki	0.63	2.57***	0.65	4.32***	0.66	9.13***
Manawatu-Wanganui	0.53	0.63	0.51	0.39	0.50	0.26
Wellington	0.47	0.02	0.48	0.16	0.45	-0.25
Nelson-Marlborough	0.51	>10.00***	0.51	>10.00***	0.50	>10.00***
Canterbury	0.51	>10.00***	0.51	>10.00***	0.50	>10.00***
West Coast	0.53	0.71	0.51	0.48	0.53	0.79
Otago	0.56	0.91	0.56	1.13	0.54	0.86
Southland	0.61	2.00**	0.55	0.87	0.44	0.04

Note: Null hypothesis is that the terms of trade and real milksolid prices variables are not concordant with the regional business cycles.

Table 10. Concordance tests of real New Zealand asset prices and regional economic activity

	Contemporaneous		Reg. activity lead 1 qtr		Reg. activity lead 4 qtrs	
	Concordance	t-stat	Concordance	t-stat	Concordance	t-stat
House prices						
Northland	0.47	-0.10	0.45	-0.18	0.41	-22.54
Auckland	0.50	0.24	0.51	0.30	0.49	0.08
Auck. (Auck. prices)	0.55	0.42	0.56	0.49	0.53	0.24
Waikato	0.57	1.19	0.56	1.00	0.48	-0.04
Bay of Plenty	0.50	0.20	0.47	-0.15	0.41	-1.35
Gisborne	0.56	0.74	0.56	0.76	0.50	0.23
Hawke's Bay	0.49	0.03	0.45	-0.28	0.45	-0.34
Taranaki	0.57	0.92	0.57	0.93	0.50	0.15
Manawatu-Wanganui	0.49	-0.04	0.49	0.02	0.47	-0.34
Wellington	0.48	-0.08	0.49	0.08	0.52	0.43
Nelson-Marlborough	0.52	0.86	0.55	-0.62	0.50	0.25
Canterbury	0.52	0.86	0.55	-0.62	0.50	0.25
West Coast	0.54	0.74	0.51	0.30	0.43	-0.51
Otago	0.46	-0.37	0.46	-0.29	0.48	-0.15
Southland	0.52	0.38	0.55	0.68	0.52	0.40
Dairy land prices						
Northland	0.59	2.61***	0.56	0.51	0.50	-0.33
Auckland	0.57	0.68	0.57	0.57	0.50	-0.25
Waikato	0.63	2.48***	0.60	1.08	0.54	0.32
Bay of Plenty	0.53	0.23	0.52	0.03	0.51	0.04
Gisborne	0.61	0.92	0.59	0.84	0.53	0.23
Hawke's Bay	0.62	4.00***	0.59	1.28	0.53	0.23
Taranaki	0.72	5.82***	0.68	2.95***	0.54	0.37
Manawatu-Wanganui	0.64	1.60*	0.65	2.01**	0.61	1.27
Wellington	0.54	0.31	0.57	0.68	0.51	0.02
Nelson-Marlborough	0.59	>10.00***	0.57	1.52*	0.55	0.36
Canterbury	0.59	>10.00***	0.57	1.52*	0.55	0.36
West Coast	0.64	2.32**	0.59	0.93	0.55	0.48
Otago	0.65	2.12**	0.64	1.92**	0.56	0.66
Southland	0.66	2.01**	0.67	2.55***	0.61	1.27

Rural land prices						
Northland	0.59	>10.00***	0.57	1.54*	0.55	0.46
Auckland	0.57	0.84	0.59	1.51*	0.50	-0.07
Waikato	0.65	7.76***	0.64	2.71***	0.50	0.04
Bay of Plenty	0.55	0.71	0.56	0.72	0.57	0.91
Gisborne	0.59	0.71	0.59	0.83	0.57	0.75
Hawke's Bay	0.62	5.61***	0.61	1.59*	0.55	0.59
Taranaki	0.74	>10.00***	0.71	7.86***	0.54	0.42
Manawatu-Wanganui	0.66	2.37***	0.69	3.34***	0.55	0.60
Wellington	0.54	0.41	0.59	1.45*	0.51	0.03
Nelson-Marlborough	0.57	>10.00***	0.56	0.97	0.48	-0.58
Canterbury	0.57	>10.00***	0.56	0.97	0.48	-0.58
West Coast	0.64	2.51***	0.65	2.41***	0.55	0.72
Otago	0.69	3.36***	0.69	4.26***	0.58	1.02
Southland	0.66	2.06**	0.69	2.86***	0.59	1.10

Note: Null hypothesis is that the real New Zealand house price, real dairy land price, and real total rural land price variables are not concordant with the regional business cycles.

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